AD-A220 314

DTIC ACCESSION NUMBER

PHOTOGRAPH THIS SHEET

LEVEL

1

INVENTORY

SC5441.QTR TR#8

DOCUMENT IDENTIFICATION

DEC 1987

DISTRIBUTION STATEMENT

ACCESSION FOR

NTIS GRA&I ☒

DTIC TRAC ☐

UNANNOUNCED

JUSTIFICATION per FINAL

AD-A211154

BY

DISTRIBUTION/

AVAILABILITY CODES

DISTRIBUTION	AVAILABILITY AND/OR SPECIAL	
A-1		

DISTRIBUTION STAMP

DATE ACCESSIONED

DATE RETURNED

DATE RECEIVED IN DTIC

REGISTERED OR CERTIFIED NUMBER

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-FDAC

DTIC FORM 70A APR 87

DOCUMENT PROCESSING SHEET

PREVIOUS EDITIONS MAY BE USED UNTIL STOCK IS EXHAUSTED

SKH1 . . .

88-3/4

Rockwell International
Science Center

AD-A220 314

DECEMBER 1987 SC5441.QTR

(6) GROWTH OF TUNGSTEN BRONZE FAMILY CRYSTALS — UL

QUARTERLY TECHNICAL REPORT NO. 8

For Period 06/01/87 through 08/31/87

(5) 6/87-8/87; 12/87

DARPA ORDER NO.:	4540
NAME OF CONTRACTOR:	Rockwell International Corp.
EFFECTIVE DATE OF CONTRACT:	05/02/85
CONTRACT EXPIRATION DATE:	01/30/88
AMOUNT OF CONTRACT DOLLARS:	$1,245,307
CONTRACT NO.:	N00014-85-C-2443
PRINCIPAL INVESTIGATOR:	Dr. R. R. Neurgaonkar (805) 373-4109
	Professor L. E. Cross Pennsylvania State University (814) 865-1181

This report covers TI number(s) NONE

Technical Information

Contracted: Date:

Sponsored By:

Initials

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DoD)
DARPA ORDER NO. 4540

(7) N00014-85-C-2443

A. OBJECTIVE

The objective of this work is to develop suitable quality and size doped and undoped $Sr_{1-x}Ba_xNb_2O_6$ (SBN) single crystals or thin films that can be used in optical device studies. The second objective of this work is to develop a phenomenological model to explain the correlation between the ferroelectric and optical properties and thereby possibly control and optimize the material performance for optical device applications.

B. PROGRESS

During the present quarter, several Ce-doped tungsten bronze SBN:60, SBN:75 and BSKNN-2 single crystals were grown and characterized. The quality and size of these crystals were excellent, allowing measurements to be made with regard to photorefractive gain coefficient (coupling constant) fanning response and spectral response with respect to the location and concentration of Ce in the structure. The photorefractive performance of these crystals was excellent in general, with SBN:60 showing the strongest photorefractive gain exceeding 45 cm^{-1}. This is the highest gain reported for any photorefractive crystal, exceeding the prior best gain of 35 cm^{-1} measured in perovskite $BaTiO_3$. Such a large gain coefficient will permit higher resolution for optical computing and also benefits laser hardening applications. Currently, we are attempting to further increase the gain in this material by optimizing the Ce^{3+}

concentration in the melt, as well as improving crystal quality further.

During the next quarter, we will expand the growth of undoped SBN:60 and SBN:75 single crystals for optical waveguides and switching applications. Over the last three months we concentrated our effort on Ce-doped tungsten bronze crystals of SBN:60, SBN:75 and BSKNN-2 compositions. Now we intend to grow both (100) and (001)-oriented SBN:60 and SBN:75 undoped single crystals for optical waveguide applications. The current results show that SBN:60 crystal quality is sufficient for these applications; however, continuous efforts are being made to improve the performance of this crystal as well as other bronze crystals.

In order to extend the spectral response of tungsten bronze crystals to the near IR region, we have introduced Cr^{3+} in the 6-fold coordinated Nb^{5+} site. Since Cr^{3+} has a size similar to Nb^{5+}, small additions of Cr^{3+} (0.1 wt%) did not alter the bronze structure or growth conditions. The growth of small crystals has been successful and it appears that the crystals are free of striations. Further efforts are under way to increase size of these crystals so we can perform ferroelectric and optical measurements.

We have successfully grown ferroelectric tungsten bronze $Sr_2KNb_5O_{15}$ thin films by the liquid phase epitaxial (LPE) technique on (100), (110) and (001)-oriented SBN:60 substrates. Since the quality of these films is much better than SBN:50 films grown on the same substrate, we are

investigating optical applications for these films, specifically guided wave optics, and according to these results, the necessary modifications in composition or growth conditions will be made.

C. MAJOR EQUIPMENT

We have purchased a cryogenic system for the characterization of these materials below 77 K.

D. CHANGE IN PERSONNEL

Jeff Nelson has joined the Ferroelectric Materials Department and will be responsible for the development of LPE thin films.

E. TRIPS AND VISITS

In August 1987, Dr. R. R. Neurgaonkar met Professor Amnon Yariv of Caltech and had discussions with him on future work.

In July and August 1987, Dr. R. R. Neurgaonkar met Drs. Dick Reynolds and John Neff of DARPA and gave a briefing on the current status of this program and outlined future work.

In July 1987, Professor L. E. Cross of Penn State University visited Rockwell for discussions on the DARPA contract and future work was planned.

F. PUBLICATIONS AND PRESENTATIONS

1. R. R. Neurgaonkar and E. T. Wu, "Epitaxial Growth of Ferroelectric Tungsten Bronze $Sr_{1-x}Ba_xNb_2O_6$ Films for

Optoelectronic Applications," Mat. Res. Bull. 22 (8), 1095 (1987).

2. R. R. Neurgaonkar, J. R. Oliver and L. E. Cross, "Epitaxial Growth of Ferroelectric Tungsten Bronze SKN Thin Films," submitted to Mat. Res. Buill.
3. G. L. Wood, W. W. Clark III, M. J. Miller, E. J. Sharp, G. J. Salamo and R. R. Neurgaonkar, "Broadband Photorefractive Properties and Self-Pumped Phase Conjugation in Ce-doped SBN:60," IEEE J. Quant. Electron. 23 (12), 2126 (1987).
4. S. Ducharme, J. Feinberg and R. R. Neurgaonkar, "Electro-Optic and Piezoelectric Measurements in Photorefractive $BaTiO_3$ and SBN," IEEE J. Quant. Electron. 23 (12), 2116 (1987).
5. R. R. Neurgaonkar, W. K. Cory, J. R. Oliver, M. J. Miller, W. W. Clark III, G. L. Wood and E. J. Sharp, "Growth of Ferroelectric Tungsten Bronze $Ba_{2-x}Sr_xK_{1-y}Na_yNb_5O_{15}$ Composition Crystals," J. Cryst. Growth 84, 629 (1987).
6. R. R. Neurgaonkar, W. K. Cory, J. R. Oliver and L. E. Cross, "Ferroelectric Properties of La^{3+}-Modified $Sr_{0.6}Ba_{0.4}Nb_2O_6$ Single Crystals," submitted to J. Cryst. Growth.

G. FUTURE WORK

Continue to establish the optimum cerium concentration in the 12- and 9-fold coordinated sites needed to improve the photorefractive response. The efforts will be

extended to grow optical quality crystals of La^{3+}-doped SBN:60 or SBN:75 compositions for pyroelectric detector and optical applications. Continue to improve the LPE technique to include different types of bronze compositions.

H. FUNDING

Contract Estimated Cost	$1,155,549
Fixed Fee	$ 89,758
Total Estimated Contract Price	$1,245,307
Current Contract Funding	$1,245,307
Less Fee	$ 89,758
Available Cost	$1,155,549
Expenditure through 08/28/87 (Cost)	$ 429,668*
Balance of Available Funds (Cost)	$ 725,881

* Including $11,898 outstanding commitments